IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Yan Borodovsky	Art Unit:	1756
Serial No.:	10/693,373	Examiner:	Daborah Chacko Davis
Filed:	October 24, 2003	Assignee:	Intel Corporation
Title:	COMPOSITE OPTICAL LITHOGRAPHY METHOD FOR PATTERNING LINES OF UNEQUAL WIDTH		

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Commissioner for Patents
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BRIEF ON APPEAL

This Brief on Appeal perfects the Notice of Appeal filed March 29, 2007.

(1) **Real Party in Interest**

This case is assigned of record to Intel Corporation, who is the real party in interest.

(2) **Related Appeals and Interferences**

There are no known related appeals and/or interferences.

(3) **Status of Claims**

Claims 1-13 and 25-27 are pending and under consideration.

Claims 14-24 have been canceled.

Claims 1-13 and 25-27 stand rejected.

Claims 1, 10, and 25 are in independent form.

Claims 1-13 and 25-27 are involved in the appeal, either directly or by virtue of depending from one of independent claims 1, 10, and 25.

(4) Status of Amendments

A response after final rejection was filed under 37 C.F.R. § 1.116 on February 28, 2007.

An advisory action mailed March 2`, 2007 indicated that the proposed amendment(s) would be entered for purposes of appeal.

(5) Summary of Claimed Subject Matter

Claim 1 relates to a system that includes:

a first apparatus to radiate an interference pattern of lines and spaces on a photoresist, (*See, e.g., specification*, page 4, line 6-9; page 5, line 2-13; page 7, line 16 - page 8, line 3; page 16, line 12-17) the lines having a substantially equal first width and remaining unexposed to radiation, the spaces being exposed to radiation (*Id.*, page 4, line 6-9; page 5, line 18 - page 6, line 3); and

a second apparatus to radiate selected areas of the photoresist (*Id.*, page 10, line 20 - page 11, line 2; page 16, line 18 - page 17, line 2; page 18, line 8 - page 19, line 6), the selected areas exposing portions of the lines to radiation, (*Id.*, page 11, line 8-10), wherein a pitch of the selected areas exposed by the second subsystem is at least one and a half times a pitch of the interference pattern (*Id.*, page 14, line 8-11); and

an alignment apparatus to align the selected areas radiated by the second apparatus with the interference pattern radiated by the first apparatus (*Id.*, page 18, line 1-7; page 19, line 8-20) to trim and narrow the first width of at least some of the lines (*Id.*, page 10, line 8-13; page 11, line 11-17).

Claim 10 relates to a method that includes:

forming an interference pattern of non-exposed lines and exposed spaces on a photoresist, the lines having a first width (*Id.*, page 4, line 6-9; page 5, line 18 - page 6, line 3);

exposing a portion of at least one line to radiation to form features with a second width (*Id.*, page 11, line 8-10), the second width being less than the first width (*Id.*, page 10, line 11-13), wherein a pitch of the features is at least one and a half times a pitch of the interference pattern (*Id.*, page 14, line 8-11).

Claim 25 relates to a method that includes:

using interference lithography to expose an interference pattern of non-exposed lines and exposed spaces on a photoresist, wherein the interference pattern has a first pitch (*See, e.g., specification*, page 4, line 6-9; page 5, line 2-13; page 7, line 16 - page 8, line 3; page 16, line 12-17); and

using a second lithography process to trim and narrow a width of at least some of the non-exposed lines by exposing portions of the non-exposed lines using a second exposure having a second pitch (*Id.*, page 10, line 8-13; page 11, line 11-17), wherein the second pitch is different from the first pitch (*Id.*, page 14, line 8-11).

(6) Grounds of Rejection to be Reviewed on Appeal

As set forth in the following concise statements, the following grounds for rejection are presented for review on appeal:

Ground 1: whether claims 10-12 are properly rejected under 35 U.S.C. § 102(b) as anticipated by European Patent Application No. 0915384 to Canon Kabushiki Kaisha (hereinafter "Canon"); and

Ground 2: whether claims 1-3, 5, 7, and 25-27 are properly rejected under 35 U.S.C. § 103(a) as obvious over Canon and U.S. Patent No. 5,415,835 to Brueck et al. (hereinafter "Brueck").

(7) Argument

The organization of the arguments presented hereinafter follows the organization of the grounds for rejection to reviewed on appeal set forth above. In particular, separate boldfaced headings for the grounds presented for review follow.

Ground 1: Rejections under 35 U.S.C. § 102(b)

Claim 10

The rejection of claim 10 under 35 U.S.C. § 102(b) is based on the contention that FIGS. 11A-11D and 9A-9B of Canon describe exposing a portion of at least one non-exposed line of an interference pattern to radiation to form features with a second width that is less than the width of the non-exposed lines of the interference pattern, as recited in claim 10. Applicant respectfully disagrees.

In this regard, Canon describes a system that uses "multiplex exposure amounts" to produce a pattern. *See, e.g., Canon*, para. [0106]. According to Canon, multiplex exposure amounts are achieved when three or more exposure levels (including zero level exposures) are used. This contrasts with the two exposure levels of a binary exposure levels system. *Id.*, para. [0032]. FIGS. 8A, 8B, 9A, 9B of Canon illustrate Canon's use of multiple exposure levels. In particular, the exposure levels denoted "0" and "1" are below the threshold exposure level "E_{th}" whereas the exposure levels denoted "2" and "3" are above the threshold exposure level "E_{th}." Canon thus relies upon the accumulation of successive dosages to define regions that are above the threshold exposure level "E_{th}."

Perhaps because Canon relies upon the accumulation of successive dosages, none of the features in Canon have a width that is less than the width of the non-exposed lines of Canon's interference patterns. Instead, the narrowest features in Canon are those formed in by Canon's interference patterns.

This is most plainly seen in Canon's FIGS. 11A-11D. In particular, FIG. 11A shows a periodic exposure pattern made through dual-beam interference exposure. This exposure pattern has a period of 0.2 micron and a line-and-space pattern with a 0.1 micron line width. *See Canon*, para. [0082]. For the sake of convenience, FIG. 11A is now reproduced.

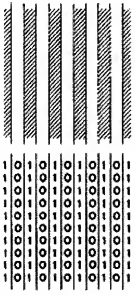

FIG. 11A

Please note that the "width of the non-exposed lines" in FIG. 11A is the width of the lines marked "0," i.e., 0.1 microns.

Canon's FIG. 11B shows the positioning and dosage of an exposure pattern defined using "ordinary projection exposure." The positioning is illustrated relative to the dual-beam interference exposure pattern. *See Canon*, para. [0101]. For the sake of convenience, FIG. 11B is now reproduced.

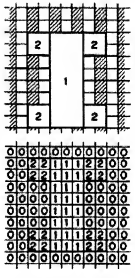

FIG. 11B

Please note that the smallest width of any portion of the "ordinary projection" exposure pattern is twice the width of the non-exposed lines in the interference exposure pattern, i.e., 0.2 microns.

Canon's FIG. 11C shows the positioning and dosage of an exposure pattern that results from the "accumulation or superposition" of the interference pattern of FIG. 11A and the "ordinary projection" exposure pattern of FIG. 11B. *See Canon*, para. [0105]. For the sake of convenience, FIG. 11C is now reproduced.

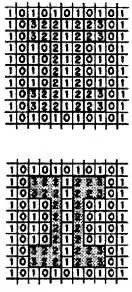

FIG. 11C

Canon's "accumulation or superposition" pattern is thus the accumulation of the interference lithography pattern and the "ordinary projection exposure" pattern. The smallest width of any feature of the "accumulation or superposition" pattern is the width of the lines and spaces in FIG. 11A, i.e., 0.1

microns. This is perhaps not surprising, given that Canon's purpose in combining of interference lithography and "ordinary projection exposure" is to achieve the circuit pattern of FIG. 10. *See Canon*, para. [0104].

Since the smallest width of any feature in the "accumulation or superposition" pattern of FIG. 11A (i.e., 0.1 microns) is the same as the width of the non-exposed lines in FIG. 11A (i.e., 0.1 microns), Canon's FIG. 11A-11C neither describe nor suggest exposing a portion of at least one line to radiation to form features with a second width that is less than the width of the non-exposed lines of the interference pattern, as recited in claim 10.

FIGS. 9A and 9B also fail to describe or suggest exposing a portion of at least one line to radiation to form features with a second width that is less than the width of the non-exposed lines of the interference pattern, as recited in claim 10. From FIG. 9B, it is clear that the line width of the "accumulation or superposition" pattern is three times larger than the underlying lithographic exposure pattern of FIG. 5. *See Canon*, para. [0073]. No features with a second width that is less than the width of the non-exposed lines of the interference pattern are formed.

Accordingly, claim 10 is not anticipated by Canon. Applicant respectfully requests that the rejection of claim 10, and the claims dependent therefrom, be withdrawn.

Ground 2: Rejections under 35 U.S.C. § 103(a)

Claim 25

The rejection of claim 25 is based on the contention that it would have been obvious for one of ordinary skill to have combined Canon and Brueck and arrived at the subject matter recited in claim 25.

Applicant respectfully disagrees. In this regard, as discussed above, Canon uses multiplex exposure amounts to produce a pattern. Canon's multiplex exposure relies upon the accumulation of successive dosages to define regions that are above a threshold exposure level "E_{th}" that demarcates regions that print from regions that do not print.

Against this backdrop, the rejection of claim 25 contends that it would have been obvious for one of ordinary skill to turn to Brueck and use a second lithography process to trim and narrow a width of Canon's non-exposed lines by exposing portions of the non-exposed lines using a second exposure having a second pitch, as recited in claim 25.

Applicant respectfully disagrees. In this regard, Brueck describes that "complex, two-dimensional patterns" can be formed by crossing multiple sets of interferometric exposures. *See, e.g., Brueck*, col. 2, line 38-46. In particular, a substrate can be rotated (with or without concomitant changes in process parameters such as beam angle) so that the grating patterns of multiple interferometric exposures cross and the net exposure patterns of FIGS. 8-14 are formed. *Id.*, col. 5, line 6 - col. 6, line 17.

Applicant respectfully submits that Brueck's crossed grating patterns neither describe nor suggest trimming and narrowing a width of at least some of the non-exposed lines of an interference pattern by exposing portions of the non-exposed lines using a second exposure, as recited in claim 24. In this regard, with crossed gratings, the lines of each grating are inherently cut by the lines of another grating. The result is the Moiré patterns seen in Brueck's FIGS. 8-14, where lines have been replaced by Brueck's "complex, two-dimensional patterns." The formation of Brueck's complex, two-dimensional patterns does not trim and narrow a width of at least some of the non-exposed lines of an interference pattern. Instead, the crossed grating patterns cuts lines, leaving Brueck's complex, two-dimensional patterns instead.

Moreover, the rejection has never set forth how Brueck's crossed interferometric exposures are to be combined with Canon's multiplex exposure to arrive at the claimed subject matter. As discussed above, Canon uses the accumulation/superimposition of dosages from multiple exposures to demarcate printing from non-printing regions. However, the rejection is silent as to the relationship between the dosages delivered by Brueck's crossed interferometric exposures and the exposure thresholds relied upon by Canon. For example, an attempt to trim a non-exposed region (i.e., a "0" region) using a "1" exposure will still leave that region below Canon's threshold exposure level (i.e., at an exposure level "1"). Since Canon's "1" and "0" exposure levels are both below the threshold exposure level, they will both be printed or not printed together.

This failure to explain the basis of the rejection fails to meet the requirements of 35 U.S.C. § 132 and 37 C.F.R. § 1.104(2), which require that the reasons for any adverse action actually be stated in an Office action. Accordingly, the rejection is facially deficient and Applicant requests that it be withdrawn.

Moreover, the rejection is based on the contention that it would have been obvious for one of ordinary skill to have combined Canon and Brueck and arrive at the subject matter recited in claim 25. However, there is no reason to believe that Brueck and Canon, when combined, do in fact lead to the recited subject matter. No such reason has been stated in an Office action. Instead, the rejection is content to speculate that Brueck and Canon could potentially be combined in some undisclosed way to achieve the recited subject matter. Applicant submits that such speculation is simply insufficient to meet the burden of establishing obviousness.

Since there is no reason to believe that one of ordinary skill would arrive at the subject matter recited in claim 25 even if Canon and Brueck were combined, claim 25 is not obvious over Canon and Brueck. Applicant therefore requests that the rejections of claim 25 and the claims dependent therefrom be withdrawn.

Claim 1

The rejection of claim 1 is based on the contention that it would have been obvious for one of ordinary skill to have combined Canon and Brueck to have arrived at the subject matter recited in claim 1.

Applicant respectfully disagrees. In this regard, as discussed above, Brueck's crossed grating patterns neither describe nor suggest that the width of at least some of the unexposed lines of a photoresist are trimmed and narrowed, as recited in claim 1. Instead, with Brueck's crossed grating patterns, the lines of each grating are inherently cut by the lines of another grating. The result is the Moiré patterns seen in Brueck's FIGS. 8-14, where lines have been replaced by Brueck's "complex, two-dimensional patterns."

Moreover, the rejection has never set forth how Brueck's crossed interferometric exposures are to be combined with Canon's multiplex exposure thresholds to trim and narrow lines. This fails to meet the requirements of 35 U.S.C. § 132 and 37 C.F.R. § 1.104(2) and the rejection is facially deficient. Indeed, since there is no reason to believe that Brueck and Canon, when combined, do in fact lead to the recited subject matter, the burden of establishing obviousness has not been met.

Moreover, claim 1 also recites an alignment apparatus that is to align the selected areas radiated by a second apparatus with an interference pattern radiated by a first apparatus to trim and narrow width of at least some of the lines of the interference pattern.

However, Brueck's complex, two-dimensional patterns are formed by single or multiple sets of interferometric exposures with crossed grating patterns. Each of these grating patterns is a periodic pattern that covers a relatively large area. Perhaps unsurprisingly, Brueck fails to describe or suggest that these areas are to be aligned using an alignment apparatus, as recited in claim 1. Instead, Brueck's only use of an alignment apparatus is when patterns are formed in multiple photosensitive layers--a situation which does not trim and narrow the width of at least some unexposed lines, as recited. *See, e.g., Brueck*, col. 4, line 31-40.

As for conventional lithography techniques, Brueck describes that the *entire width* of a non-exposed line can be exposed using conventional lithography techniques. Such an exposure of the entire width of a non-exposed line neither describes nor suggests an alignment apparatus to align the selected areas radiated by a second apparatus with an interference pattern radiated by a first apparatus to trim and narrow width of at least some of the lines of the interference pattern, as recited in claim 1. Rather, exposure of the entire width of a line removes the entire line.

Accordingly, claim 1 is not obvious over Canon and Brueck. Applicant therefore requests that the rejections of claim 1 and the claims dependent therefrom be withdrawn.

The brief fee of $500 is enclosed. Please apply any other charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

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Appendix of Claims

1. A system comprising:

a first apparatus to radiate an interference pattern of lines and spaces on a photoresist, the lines having a substantially equal first width and remaining unexposed to radiation, the spaces being exposed to radiation; and

a second apparatus to radiate selected areas of the photoresist, the selected areas exposing portions of the lines to radiation, wherein a pitch of the selected areas exposed by the second subsystem is at least one and a half times a pitch of the interference pattern; and

an alignment apparatus to align the selected areas radiated by the second apparatus with the interference pattern radiated by the first apparatus to trim and narrow the first width of at least some of the lines.

2. The system of Claim 1, wherein a second width of a feature formed by the second apparatus is equal to the first width of a line of the interference pattern.

3. The system of Claim 1, wherein a second width of a feature formed by the second apparatus is less than the first width of a line of the interference pattern.

4. The system of Claim 1, wherein the second apparatus uses optical proximity correction (OPC) on a mask to adjust feature widths.

5. The system of Claim 1, wherein the first apparatus comprises a beamsplitter.

6. The system of Claim 1, wherein the first apparatus comprises a diffraction grating.

7. The system of Claim 1, wherein the second apparatus comprises a mask-based optical lithography tool.

8. The system of Claim 1, wherein the second apparatus comprises an electron beam lithography tool.

9. The system of Claim 1, wherein the second apparatus comprises a maskless optical lithography tool with a database.

10. A method comprising:

forming an interference pattern of non-exposed lines and exposed spaces on a photoresist, the lines having a first width;

exposing a portion of at least one line to radiation to form features with a second width, the second width being less than the first width, wherein a pitch of the features is at least one and a half times a pitch of the interference pattern.

11. The method of Claim 10, wherein a pitch of the features is greater than one and a half times a pitch of the interference pattern.

12. The method of Claim 10, wherein the radiation has a pre-determined wavelength, the interference pattern approaching a pitch equal to the wavelength divided by two.

13. The method of Claim 10, further comprising generating a print mask from Boolean subtraction of (a) a final design layout for a given layer from (b) the interference pattern.

14.-24. (Canceled)

25. A method comprising:

using interference lithography to expose an interference pattern of non-exposed lines and exposed spaces on a photoresist, wherein the interference pattern has a first pitch; and

using a second lithography process to trim and narrow a width of at least some of the non-exposed lines by exposing portions of the non-exposed lines using a second exposure having a second pitch, wherein the second pitch is different from the first pitch.

26. The method of claim 25, wherein the second pitch is at least one and a half times the first pitch.

27. The method of claim 25, wherein using the second lithography process comprises using a lens-based lithography process.

Evidence Appendix

None.

Related Proceedings Appendix

None.